PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-004428
(43)Date of publication of application : 08.01.2004

(51)Int.Cl. G02B 6/42
G02B 6/122
H05K 1/02
H05K 1/14
H05K 3/46

(21)Application number : 2002-213940
(22)Date of filing : 23.07.2002

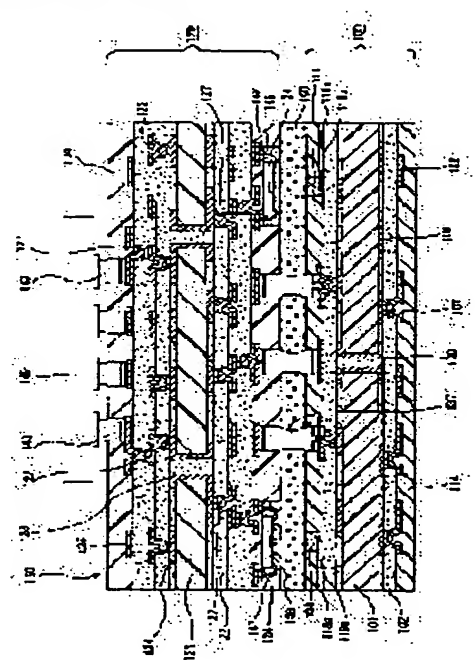
(71)Applicant : IBIDEN CO LTD
(72)Inventor : ASAI MOTOO
TANAKA TOYOAKI

(30)Priority

Priority number	Priority date	Priority country
2002099307	01.04.2002	JP
2001399448	28.12.2001	JP

(54) DEVICE FOR OPTICAL COMMUNICATIONS AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a device for optical communications by which dust and foreign matters or the like floating in air are prevented from entering a space between an optical device and an optical waveguide by forming a sealing resin layer between a printed board for packaging an IC chip and a multilayer printed wiring board and also whose reliability is high by mitigating stress caused by the difference in the coefficients of thermal expansion between the printed board for packaging the IC chip and the multilayer printed wiring board.
SOLUTION: The device for the optical communications is constituted of the printed board for packaging the IC chip where at least the optical device is packaged and the multilayer printed wiring board where at least the optical waveguide is formed, and an optical signal is transmitted by the optical waveguide and the optical device, and the enclosed resin layer is formed between the printed board for packaging the IC chip and the multilayer printed wiring board.



LEGAL STATUS
[Date of request for examination] 08.06.2005
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1]
The substrate for IC chip mounting with which the optical element was mounted at least,
It consists of a multilayer printed wiring board with which optical waveguide was formed at least,
It is the device for optical communication constituted so that said optical waveguide and said optical element can transmit a lightwave signal,
The device for optical communication characterized by forming the closure resin layer between said substrates for IC chip mounting and said multilayer printed wiring boards.
[Claim 2]
Said closure resin layer is a device for optical communication according to claim 1 whose transmission of communication link wavelength light is 70% or more.
[Claim 3]
The device for optical communication according to claim 1 or 2 with which the particle is contained in said closure resin layer.
[Claim 4]
Said optical element is a device for optical communication given in any 1 of claims 1-3 which are a photo detector and/or a light emitting device.
[Claim 5]
After manufacturing separately the substrate for IC chip mounting with which the optical element was mounted at least, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, the manufacture approach of the device for optical communication characterized by forming a closure resin layer by performing hardening processing after slushing the resin constituent for the closures between said substrates for IC chip mounting and said multilayer printed wiring boards.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the manufacture approach of the device for optical communication, and the device for optical communication.
[0002]
In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed.
An optical fiber **1 Low loss, **2 High bandwidth, **3 A narrow diameter and a light weight, **4 No guiding, **5 In the communication system using the optical fiber which has the descriptions, such as saving resources, and has this description, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced substantially, construction and maintenance become easy, and economization of communication system and high-reliability-ization can be attained.
[0003]
Moreover, since an optical fiber can multiplex simultaneously the light of the wavelength from which not only the light of one wavelength but many differ with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004]
Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed.
[0005]
Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, for example, optics, such as a package substrate which mounted IC chip, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted independently, electric wiring and optical waveguide were connected to these, and a signal transmission and signal processing were performed.
[0006]
[Problem(s) to be Solved by the Invention]
In such a conventional terminal equipment, since IC mounting package substrate and the optic were mounted independently, the whole equipment became large and had become the factor which bars the miniaturization of a terminal equipment.
Moreover, in the conventional terminal equipment, since the distance of IC mounting package substrate and an optic was separated, electric wiring distance is long and it was easy to generate the signal error by a cross talk noise etc. at the time of a signal transmission.
[0007]
Moreover, in the conventional device for optical communication, between optical waveguide and optical elements, such as a photo detector and a light emitting device, when it is an opening and dust and the foreign matter which are floating the inside of air into this part entered, transmission of a lightwave signal was checked with this foreign matter etc., and the connection loss between optics might usually increase.

[0008]
[Means for Solving the Problem]
Then, while this invention persons can attain the optical communication which is excellent in connection dependability by mounting various optics in the substrate for IC chip mounting as a result of inquiring wholeheartedly By being able to contribute to the miniaturization of a terminal equipment, and carrying out opposite arrangement of the substrate for IC chip mounting, and the multilayer printed wiring board, and forming a closure resin layer among both Since the stress which the foreign matter which is floating the inside of air does not enter between each optic, in addition is generated between the substrate for IC chip mounting and a multilayer printed wiring board can be eased, The device for optical communication of this invention which consists of a header and the following configuration becoming the device for optical communication which is excellent in dependability was completed.
[0009]
That is, the device for optical communication of this invention consists of a substrate for IC chip mounting with which the optical element was mounted at least, and a multilayer printed wiring board with which optical waveguide was formed at least,
It is the device for optical communication constituted so that the above-mentioned optical waveguide and the above-mentioned optical element can transmit a lightwave signal,
It is characterized by forming the closure resin layer between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board.
[0010]
As for the above-mentioned closure resin layer, in the device for optical communication of this invention, it is desirable for the permeability of communication link wavelength light to be 70% or more.
Moreover, it is desirable to contain the particle in the above-mentioned closure resin layer.
Moreover, as for the above-mentioned optical element, in the device for optical communication of this invention, it is desirable that they are a photo detector and/or a light emitting device.
[0011]
Moreover, the manufacture approach of the device for optical communication of this invention is, after manufacturing independently the substrate for IC chip mounting with which the optical element was mounted at least, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, after slushing the resin constituent for closure between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0012]
[Embodiment of the Invention]
Hereafter, the device for optical communication of this invention is explained.
The device for optical communication of this invention consists of a substrate for IC chip mounting with which the optical element was mounted at least, and a multilayer printed wiring board with which optical waveguide was formed at least,
It is the device for optical communication constituted so that the above-mentioned optical waveguide and the above-mentioned optical element can transmit a lightwave signal,
It is characterized by forming the closure resin layer between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board.
[0013]
Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the optical element was mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
Moreover, in the above-mentioned device for optical communication, since an optic and electronic parts required for optical communication can be unified, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0014]
Moreover, since the closure resin layer is formed between the substrate for IC chip mounting, and the multilayer printed wiring board, between an optical element and optical waveguide, dust, a foreign matter, etc. which are floating the inside of air do not enter, and transmission of a lightwave signal is not checked with this dust, foreign

matter, etc.

[0015]

Furthermore, since the duty with which the above-mentioned closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board can be achieved, fracture near the solder bump which connects the substrate for IC chip mounting and a multilayer printed wiring board etc. can be prevented. Moreover, by forming the above-mentioned closure resin layer, it is harder to generate location gap of an optical element and optical waveguide, and transmission of the lightwave signal between an optical element and optical waveguide is not checked, either.

Therefore, the device for optical communication of this invention will be excellent in dependability also from such a point.

[0016]

Moreover, as for the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, in the device for optical communication of this invention, connecting electrically through a solder bump is desirable. It is because both can be more certainly stationed to a position according to the self-alignment operation which solder has.

In addition, it is thought that it happens in order that the surface tension which is going to become a globular form when solder is attached to a metal, while the operation which is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity to which self has [solder] a self-alignment operation at the time of reflow processing is said and, as for this operation, solder is crawled by the solder resist layer may work strongly. Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected on the above-mentioned multilayer printed wiring board through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on the above-mentioned multilayer printed wiring board.

therefore, if it is alike, respectively and optics, such as a photo detector, a light emitting device, and optical waveguide, are attached in the exact location, the device for optical communication which is excellent in connection dependability can be manufactured by [of the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board] connecting the above-mentioned substrate for IC chip mounting on the above-mentioned multilayer printed wiring board through a solder bump.

[0017]

Hereafter, the device for optical communication of this invention is explained, referring to a drawing.

Drawing 1 is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 1 R> 1.

[0018]

As shown in drawing 1 , the device 150 for optical communication consists of the substrates 120 for IC chip mounting and multilayer printed wiring boards 100 which mounted the IC chip 140, and the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 are electrically connected through the solder connection 137.

Moreover, the closure resin layer 160 is formed between the substrate 120 for IC chip mounting, and the multilayer printed wiring board 100.

[0019]

the mounting substrate 120 for IC chip — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the resin insulating layer [a circuit 124 and] 122 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 122 between layers — circuits are electrically connected by the through hole 129 and the Bahia hall 127, respectively.

moreover, in one outermost layer of drum of the mounting substrate 120 for IC chip The solder resist layer 134 equipped with the solder bump for mounting IC chip is formed. To a part of outermost layer of drum (a multilayer printed wiring board 100 and solder resist layer which counters) of another side of the substrate 120 for IC chip mounting Each of the photo detector 138 of a wirebonding mold and a light emitting device 139 is contained and fixed, and the wire 146 connects electrically further between the conductor layers 142 formed in the substrate for IC chip mounting. In addition, immobilization of a photo detector 138 and a light emitting device 139 is performed by the resin for die bondings (not shown).

Moreover, as for each of the photo detector 138 contained by the solder resist layer 134 and a light emitting device 139, the perimeter is closed with resin 147.

[0020]
a multilayer printed wiring board 100 — both sides of a substrate 101 — a conductor — the conductor with which laminating formation was carried out and the substrate 101 of the resin insulating layer [a circuit 104 and] 102 between layers was pinched — the conductor which sandwiched circuits and the resin insulating layer 102 between layers — circuits are electrically connected by the through hole 109 and the Bahia hall 107, respectively.
Moreover, the solder resist layer 114 equipped with the opening 111 for optical paths in which the resin layer 108 for optical paths was formed, and a solder bump is formed in the interior, and the optical waveguide 118 (118a, 118b) equipped with the optical-path conversion mirror 119 (119a, 119b) is formed directly under [for optical paths] opening 111 (111a, 111b) in the mounting substrate 120 for IC chip of a multilayer printed wiring board 100, and the outermost layer of drum of the side which counters.
[0021]
In the device 150 for optical communication which consists of such a configuration The lightwave signal sent from the outside through an optical fiber (not shown) etc. After being introduced into optical waveguide 118a and sent to the photo detector 138 (light sensing portion 138a) through optical-path conversion mirror 119a, opening 111for optical paths a, and the closure resin layer 160, it changes into an electrical signal by the photo detector 138 — having — further — a conductive layer 142 and a conductor — it will be sent to the IC chip 140 through a circuit 124, the Bahia hall 127, a through hole 129, and the solder connection 143.
[0022]
Moreover, the electrical signal sent out from the IC chip 140 the solder connection 143 and a conductor, after being sent to a light emitting device 139 through a circuit 124, the Bahia hall 127, a through hole 129, and a conductive layer 142 And optical-path conversion mirror 119b Mind, and it is introduced into optical waveguide 118b. it changes into a lightwave signal by the light emitting device 139 — having — this lightwave signal — the closure resin layer 160 from a light emitting device 139 (light-emitting part 139a), and opening 111for optical paths b — furthermore, it is delivery outside as a lightwave signal through an optical fiber (not shown) etc. — it will be carried out.
[0023]
In such a device for optical communication of this invention, since the closure resin layer is formed between the substrate for IC chip mounting, and the multilayer printed wiring board, dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide, and transmission of a lightwave signal is not checked with this dust, foreign matter, etc.
[0024]
Moreover, in the above-mentioned device for optical communication, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder bump — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included).
[0025]
Moreover, the operation gestalt of the device for optical communication of this invention may have the gestalt which it is not necessarily limited to the gestalt shown in drawing 1 , for example, is shown in drawing 2 or drawing 3 .
Drawing 2 is the sectional view showing typically another example of the device for optical communication of this invention, and drawing 3 is the sectional view showing typically another example of the device for optical communication of this invention.
[0026]
Only the gestalten with which the device for optical communication which showed the device for optical communication shown in drawing 2 to drawing 1 , and its structure are abbreviation identitases, and fix an optical element (a photo detector and light emitting device) to the substrate for IC chip mounting differ.
That is, in the device 250 for optical communication shown in drawing 2 to the optical element being fixed with the resin for die bondings with the device 150 for optical communication shown in drawing 1 , the photo detector 238 and the light emitting device 239 are being fixed with solder 244, respectively. In addition, solder 244 has played only the role which fixes an optical element, and electric connection of an optical element is made with the wire 246.
Thus, it is only differing from the device 150 for optical communication with which the gestalt fixed to the

substrate for IC chip mounting showed the optical element to drawing 1 , and the other structures of the device 250 for optical communication shown in drawing 2 are the same as that of the device 150 for optical communication.

[0027]

The device for optical communication which showed the device for optical communication shown in drawing 3 to drawing 1 , and its structure are abbreviation identitases, and only the mounting gestalten of an optical element (a photo detector and light emitting device) differ.

That is, in the device 150 for optical communication shown in drawing 1 , the optical element of a wirebonding mold is used as an optical element, and this optical element is being fixed with the resin for die bondings. On the other hand, in the device 350 for optical communication shown in drawing 3 , the thing of a flip chip mold is used as a photo detector 338 and a light emitting device 339, and both immobilization of a photo detector 338 and a light emitting device 339 and electric connection are made with solder 344.

Moreover, in the device 350 for optical communication, the resin seal also of the gap of the base (the field which has a light sensing portion and a light-emitting part, and field of an opposite hand) of a photo detector 338 and a light emitting device 339, and the solder resist layer 334 is carried out.

Thus, it is only that the shown device 350 for optical communication differs from the device 150 for optical communication which the mounting gestalt of an optical element showed to drawing 1 drawing 3 , and other structures are the same as that of the device 150 for optical communication.

[0028]

Furthermore, the device for optical communication of this invention may have the gestalt shown in drawing 14 and drawing 15 . Drawing 14 is the sectional view showing typically another example of the device for optical communication of this invention, and drawing 15 is the sectional view showing typically another example of the device for optical communication of this invention.

[0029]

Compared with the device for optical communication which showed the device for optical communication shown in drawing 14 to drawing 1 , the mounting positions of an optical element (a photo detector and light emitting device) differ, and it differs further in that the optical path for lightwave signal transmission for transmitting a lightwave signal between this optical element and optical waveguide is formed.

That is, with the device 150 for optical communication shown in drawing 1 , the photo detector 438 and the light emitting device 439 are mounted in the field of an opposite hand with the device 450 for optical communication shown in drawing 14 on both sides of the side and substrate which counter the multilayer printed wiring board 400 of the substrate 420 for IC chip mounting to the optical element being mounted in the multilayer printed wiring board 100 of the substrate 120 for IC chip mounting, and the field of the side which counters. In addition, the photo detector 438 and the light emitting device 439 are mounted in the substrate for IC chip mounting through solder.

[0030]

Moreover, the optical path 441 for lightwave signal transmission for transmitting a lightwave signal between each of a photo detector 438 and a light emitting device 439 and optical waveguide 418 is formed in the substrate 420 for IC chip mounting. While the resin layer 442 for optical paths is formed in the interior, as for the optical path 441 for lightwave signal transmission, the conductor layer 445 is formed in the wall surface.

Furthermore, it is closed with resin 447 between each underside of a photo detector 438 and a light emitting device 439, and the solder resist layer 434.

In the device 450 for optical communication which has such a configuration, a lightwave signal can be transmitted through the optical path 441 for lightwave signal transmission between an optical element (a photo detector 438 and light emitting device 439) and optical waveguide 118.

Thus, it is only that the mounting position of an optical element and the point that the optical path for lightwave signal transmission is formed differ from the device 150 for optical communication shown in drawing 1 , and the other structures of the device 450 for optical communication shown in drawing 14 are the same as that of the device 150 for optical communication.

[0031]

Compared with the device for optical communication which showed the device for optical communication shown in drawing 15 to drawing 3 , it differs in that the optical path for signal transmissions to which the formation locations of optical waveguide differ and penetrate the resin insulating layer between a substrate and layers and the solder resist layer of one side further is formed in the multilayer printed wiring board.

That is, in the multilayer printed wiring board 300 which constitutes the device 350 for optical communication shown in drawing 3 , optical waveguide 318 is formed on the resin insulating layer between layers of the substrate 320 for IC chip mounting, and the outermost layer of drum of the side which counters. On the other

hand, in the multilayer printed wiring board 500 shown in drawing 15 , optical waveguide 518 is formed on both sides of the side and substrate which counter the substrate 520 for IC chip mounting on the resin insulating layer between layers of the outermost layer of drum of an opposite hand.
[0032]
Furthermore, in the multilayer printed wiring board 500, the optical path 551 for lightwave signal transmission which penetrates a substrate 501, the resin insulating layer 502 between layers and the substrate 520 for IC chip mounting, and the solder resist layer 514 of the side which counters is formed. In addition, the resin layer 552 for optical paths is formed in the interior, and, as for the optical path 551 for lightwave signal transmission, the conductor layer 555 is formed in the wall surface.
In the device 550 for optical communication which consists of such a configuration, a lightwave signal can be transmitted through the optical path 551 for lightwave signal transmission formed in the multilayer printed wiring board 500.
Thus, it is only that the formation location of optical waveguide and the point that the optical path for lightwave signal transmission is formed differ from the device 350 for optical communication shown in drawing 3 , and the other structures of the device 550 for optical communication shown in drawing 15 are the same as that of the device 350 for optical communication.
[0033]
Thus, the formation location of the optical waveguide in the device for optical communication of this invention may be like the multilayer printed wiring board shown in drawing 1 etc. on the resin insulating layer between layers of the substrate for IC chip mounting, and the outermost layer of drum of the side which counters, and may be on the resin insulating layer between layers of the outermost layer of drum of the opposite hand whose substrate was pinched the side which counters the substrate for IC chip mounting like the multilayer printed wiring board shown in drawing 15 . Furthermore, the formation location of the above-mentioned optical waveguide may not necessarily be limited to these, may be between the resin insulating layers between layers, and may be between a substrate and the resin insulating layer between layers.
[0034]
Next, the configuration member of the device for optical communication of this invention etc. is explained.
As the device for optical communication of this invention was mentioned above, the closure resin layer is formed between the substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board.
[0035]
As the above-mentioned closure resin layer, especially if there is little absorption by the communication link wavelength range, it will not be limited, but as the ingredient, thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was sensitization-ized, ultraviolet curing mold resin, etc. are mentioned, for example. In these, thermosetting resin is desirable. It is because it is easy to make it harden certainly. Specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.
[0036]
Moreover, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more.
At less than 70%, the transmission of communication link wavelength light has large loss of a lightwave signal, and is because it may lead to lowering of the dependability of the device for optical communication. It is more desirable for the above-mentioned permeability to be 90% or more.
When consisting only of a resinous principle which the above-mentioned closure resin layer mentioned above especially, as for the permeability, it is desirable that it is 90% or more, and when the particle is blended with the closure resin layer so that it may mention later, as for the permeability, it is desirable that it is 70% or more.
[0037]
In addition, in this description, the permeability of communication link wavelength light means the permeability of the communication link wavelength light per die length of 1mm. When the light of I1 carried out incidence to the above-mentioned closure resin layer in strength, passing this closure resin layer 1mm, and having come out, and the intensity of light which came out is I2, it is specifically the value computed by the following formula (1).
[0038]
Permeability (%) =(I2/I1) x100 ... (1)
[0039]
In addition, the above-mentioned permeability means the permeability measured at 25-30 degrees C.
[0040]

Moreover, it is desirable to contain particles, such as a resin particle, an inorganic particle, and metal particles, in the above-mentioned closure resin layer.
By including a particle, it is because it is harder coming to generate the crack which could be made to adjust a coefficient of thermal expansion between the above-mentioned substrate for IC chip mounting, or the above-mentioned multilayer printed wiring board, and originated in the difference of a coefficient of thermal expansion.
[0041]
In the device for optical communication of this invention which consists of a substrate for IC chip mounting, and a multilayer printed wiring board in addition, the coefficient of thermal expansion (z shaft orientations) of the configuration member A substrate For example, 5.0x10-5 - 6.0x10-5 (/degree C) extent, The resin insulating layer between layers 6.0x10-5 - 8.0x10-5 (/degree C) extent, 0.1x10-5 - 1.0x10-5 (/degree C) extent and a closure resin layer 0.1x10-5 - 100x10-5 (/degree C) extent, [a particle] The closure resin layer with which the particle was blended 3.0x10-5 - 4.0x10-5 (/degree C) extent, an optical element made from IC chip, silicon, germanium, etc. -- 0.5x10-5 - 1.5x10-5 (/degree C) extent and a conductor -- a circuit is 1.0x10-5 - 2.0x10-5 (/degree C) extent. In addition, the measurement temperature of the above-mentioned coefficient of thermal expansion is 20 degrees C.
Thus, if the particle is blended with the closure resin layer, the difference of the coefficient of thermal expansion of this closure resin layer and other configuration members which constitute the device for optical communication will become small. Therefore, stress will be eased.
Moreover, when the particle is blended with the closure resin layer, it is harder coming to generate location gap of an optical element and optical waveguide.
[0042]
Moreover, when blending a particle with the above-mentioned closure resin layer, the comparable thing of the refractive index of the resinous principle of this closure resin layer and the refractive index of the above-mentioned particle is desirable. Therefore, when blending a particle with a closure resin layer, it is desirable to mix two or more kinds of particles from which a refractive index differs, and to make it the refractive index of a particle become comparable as the refractive index of a resinous principle.
When a resinous principle is the epoxy resin of a refractive index 1.53, specifically, it is desirable for the silica particle and refractive index of 1.54 to mix the titania particle of 1.52, and for a refractive index to use.
In addition, after melting and mixing the approach and two or more kinds of particles to knead as an approach of mixing a particle, the approach of making it into the shape of a particle etc. is mentioned.
[0043]
What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0044]
Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned.
Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used.
Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0045]
Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. is mentioned, for example. Moreover, what was made to mix and carry out melting of a silica and the titania at a fixed rate, and was equalized may be used.
Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0046]
As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example.

These resin particles, an inorganic particle, and metal particles may be used independently, and may be used together two or more sorts.

[0047]

Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in a closure resin layer. furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse — when spherical, it will be hard to reflect light by this particle, and loss of a lightwave signal will be reduced.

[0048]

Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.

Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be included.

In addition, in this description, the particle size of a particle means the die length of the longest part of a particle.

[0049]

The minimum with the desirable loadings of the particle contained in the above-mentioned closure resin layer is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight.

In addition, what is necessary is just to choose the concrete presentation suitably so that a closure resin layer may fill the low loss nature of a lightwave signal, and the outstanding thermal resistance and crack-proof nature in order that the presentation of the above-mentioned closure resin layer may affect dependability, such as transmission loss of a lightwave signal, thermal resistance, and flexural strength.

[0050]

Moreover, the optical element (a photo detector, light emitting device) is mounted in the substrate for IC chip mounting which constitutes the device for optical communication of this invention.

As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example.

What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned device for optical communication, demand characteristics, etc.

Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector.

In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.

[0051]

As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example.

What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned device for optical communication.

[0052]

As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned.

That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.

[0053]

In addition, in case the above-mentioned optical element (a photo detector and light emitting device) is mounted in the substrate for IC chip mounting, you may connect electrically by wirebonding and it may be electrically connected by flip chip bonding.

Moreover, when the above-mentioned optical element is what is electrically connected by wirebonding, the resin for die BONDINKU is used for the substrate for IC chip mounting, it may be fixed to it, and this optical element may be fixed using solder.

[0054]

Moreover, as illustrated, in the device for optical communication of this invention, as for the optical element mounted in the substrate for IC chip mounting, it is desirable to carry out the resin seal of the perimeter, and, as for this resin seal, it is desirable to be carried out by being the thing of the construction material of a closure resin layer or the resin layer for optical paths and the same construction material. Therefore, the particle may be blended with the resin which closes the perimeter of the above-mentioned optical element, and it is desirable for the permeability to be 90% or more, when it is desirable that it is 70% or more when the particle is blended and it consists only of a resinous principle.

Moreover, when the above-mentioned optical element is what is electrically connected by flip chip bonding, it is desirable to carry out the resin seal also of between this optical element, and solder resist layers and the resin layers for optical paths.

[0055]

Moreover, although an optical element (a photo detector and light emitting device) is mounted so that it may be laid under the solder resist layer, and the resin seal of the perimeter is carried out in the substrate for IC chip mounting in the illustrated device for optical communication In the substrate for IC chip mounting which constitutes the device for optical communication of this invention It does not necessarily need to be mounted so that the whole optical element may be laid under the solder resist layer. For example, it may be mounted in the front face of a solder resist layer, without being mounted so that the part may be laid under the solder resist layer, and laying the whole under the solder resist layer.

In addition, when it is mounted so that the part may be laid underground, or also when it is mounted without laying the whole under the solder resist layer, the resin seal of the perimeter of an optical element may be carried out.

[0056]

Moreover, as for the above-mentioned substrate for IC chip mounting, it is desirable to form the solder bump for transmitting an electrical signal. Thereby, it is because an electrical signal can be transmitted between external electronic parts.

[0057]

Optical waveguide is formed in the multilayer printed wiring board which constitutes the device for optical communication of this invention.

The inorganic system optical waveguide which consists of the organic system optical waveguide and quartz glass which consist of a polymer ingredient etc., a compound semiconductor, etc. as the above-mentioned optical waveguide, for example is mentioned. In these, the organic system optical waveguide which consists of a polymer ingredient etc. is desirable. It is because it excels in adhesion with the resin insulating layer between layers and processing is easy.

[0058]

The complex of the resin and thermosetting resin with which it was not limited as the above-mentioned polymer ingredient especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned.

[0059]

Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.

[0060]

Particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned optical waveguide in addition to the above-mentioned resinous principle.

The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.

[0061]

Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in optical waveguide.

furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse — when spherical, it will be hard to reflect light by the above-mentioned particle, and loss of a lightwave signal will be reduced.
[0062]
Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be contained.
[0063]
The minimum with the desirable loadings of the particle contained in the above-mentioned optical waveguide is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight.
Moreover, although especially the configuration of the above-mentioned optical waveguide is not limited, since the formation is easy, the shape of a sheet is desirable.
[0064]
Thus, when a particle is contained in optical waveguide, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the substrate which constitutes a multilayer printed wiring board, the resin insulating layer between layers, etc., and it is harder coming to generate a crack, exfoliation, etc. resulting from the difference of a coefficient of thermal expansion.
[0065]
Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-100 micrometers, and the width of face has desirable 1-100 micrometers. the conductor which constitutes a multilayer printed wiring board if the above-mentioned width of face is not sometimes easy for the formation in less than 1 micrometer and the above-mentioned width of face exceeds 100 micrometers on the other hand — it may become the cause which checks the degree of freedom of designs, such as a circuit
[0066]
Moreover, the ratio of the thickness of the above-mentioned optical waveguide and width of face has a desirable way near 1:1. This is usually because the flat-surface configuration of the light sensing portion of the above-mentioned photo detector or the light-emitting part of the above-mentioned light emitting device is a circle configuration. In addition, especially the ratio of the above-mentioned thickness and width of face is not limited, and should just usually be about 1:2 - about 2:1 abbreviation. Furthermore, when the above-mentioned optical waveguide is the optical waveguide of the single mode which is the communication link wavelength of 1.55 micrometers, as for the thickness and width of face, it is more desirable that it is 5-15 micrometers, and when the above-mentioned optical waveguide is the optical waveguide of a multimode on the communication link wavelength of 0.85 micrometers, it is desirable [the thickness and width of face] that it is 20-80 micrometers.
[0067]
Moreover, as the above-mentioned optical waveguide, it is desirable to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc.
Moreover, it is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale or the formation to like.
[0068]
It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide, as mentioned above. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle.
Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.

[0069]
Moreover, although optical waveguide is formed on the resin insulating layer between layers of an outermost layer of drum, and the solder resist layer is further formed in the multilayer printed wiring board which constitutes the illustrated device for optical communication so that this resin insulating layer between layers and optical waveguide may be covered This solder resist layer does not necessarily need to be formed, for example, optical waveguide was formed on [of an outermost layer of drum / whole] the resin insulating layer between layers, and this optical waveguide may play a role of a solder resist layer.
[0070]
Moreover, in the above-mentioned substrate for IC chip mounting, as shown in drawing 14 , when the optical element is mounted in the multilayer printed wiring board of the substrate for IC chip mounting, the field which counters, and the field of the opposite hand whose substrate was pinched, the optical path for lightwave signal transmission is formed in this substrate for IC chip mounting. Therefore, a lightwave signal can be transmitted through this optical path for lightwave signal transmission.
[0071]
As for the above-mentioned optical path for lightwave signal transmission, it is desirable to form the resin layer for optical paths in the interior. Thus, it is because neither dust nor a foreign matter can enter more easily in the above-mentioned optical path for lightwave signal transmission that the resin layer for optical paths is formed while it is suitable for forming the above-mentioned closure resin layer.
Furthermore, when the resin layer for optical paths is formed in the interior of the above-mentioned optical path for lightwave signal transmission, the reinforcement of the substrate for IC chip mounting also becomes what was more excellent.
[0072]
Especially if the resinous principle of the above-mentioned resin layer for optical paths has little absorption by the communication link wavelength range, it will not be limited, but the thing same as an example as the resin used for the above-mentioned closure resin layer etc. is mentioned.
Moreover, particles, such as a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned resin layer for optical paths in addition to the above-mentioned resinous principle. Adjustment of a coefficient of thermal expansion can be aimed at by including these particles between the optical path for lightwave signal transmission, a substrate, the resin insulating layer between layers, a solder resist layer, etc. The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.
[0073]
Moreover, especially the configuration of the above-mentioned optical path for lightwave signal transmission is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In these, the shape of a cylinder is desirable. It is because the formation is easy.
[0074]
Moreover, the desirable minimum of the path of the cross section of the above-mentioned optical path for lightwave signal transmission is 100 micrometers. While there is a possibility that an optical path may be closed for the path of the above-mentioned cross section by less than 100 micrometers, it is because it may become difficult to form the resin layer for optical paths in the interior of this optical path for lightwave signal transmission. On the other hand, the desirable upper limit of the path of the above-mentioned cross section is 500 micrometers. the conductor which whose transmission nature of a lightwave signal seldom improves even if it makes it larger than 500 micrometers, but is formed in the substrate for IC chip mounting — it is because it may become the cause which checks the degree of freedom of a design of a circuit.
While both the paths of the above-mentioned cross section are more excellent in the transmission nature of a lightwave signal, and the degree of freedom of a design, also in case it is filled up with a non-hardened resin constituent, from the point that inconvenience does not occur, the more desirable minimum is 250 micrometers and a more desirable upper limit is 350 micrometers. In addition, in the case of the shape of the diameter of the cross section, and an elliptic cylinder, in the case of the shape of the shape of the major axis of the cross section, and the square pole, or a multiple column, the path of the cross section of the above-mentioned optical path for lightwave signal transmission means the die length of the longest part of the cross section, when the above-mentioned optical path for lightwave signal transmission is a cylinder-like.
[0075]
As for the above-mentioned optical path for lightwave signal transmission, it is desirable to form the conductor layer in the wall surface, and the above-mentioned conductor layer may consist of one layer, and may consist of more than two-layer.

As an ingredient of the above-mentioned conductor layer, copper, nickel, chromium, titanium, noble metals, etc. are mentioned, for example.
moreover, the conductor with which the above-mentioned conductor layer sandwiched the duty as a through hole, i.e., a substrate, depending on the case — the conductor which sandwiched between circuits, and a substrate and the resin insulating layer between layers — the duty which connects between circuits electrically can be achieved.
Moreover, the ingredient of the above-mentioned conductor layer may be a metal which has gloss, such as gold, silver, nickel, platinum, aluminum, and a rhodium. In the conductor layer formed using the metal which has such gloss, a lightwave signal will reflect suitably.
[0076]
Moreover, the enveloping layer and roughening layer which consist of tin, titanium, zinc, etc. may be further prepared on the above-mentioned conductor layer. By preparing the above-mentioned enveloping layer and a roughening layer, adhesion of the resin layer for optical paths can be raised.
[0077]
Moreover, when the conductor layer and the resin layer for optical paths are formed in the interior of the above-mentioned optical path for lightwave signal transmission, these may be in contact with the substrate or the resin insulating layer between layers through the roughening side. It is because it excels in adhesion with a substrate or the resin insulating layer between layers and is harder coming to generate exfoliation of a conductor layer etc., when the above-mentioned conductor layer has touched through the roughening side.
[0078]
The device for optical communication of this invention which consists of such a configuration can be manufactured by the manufacture approach of the device for optical communication of this invention mentioned later, for example.
[0079]
Next, the manufacture approach of the device for optical communication of this invention is explained.
After the manufacture approach of the device for optical communication of this invention manufactured independently the substrate for IC chip mounting with which the optical element was mounted at least, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, after slushing the resin constituent for closure between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0080]
By the manufacture approach of the device for optical communication of this invention , since a closure resin layer be form among both after arrange and fix the substrate for IC chip mounting , and a multilayer printed wiring board to a position , the device for optical communication with which dust , a foreign matter , etc. which be float the inside of air do not enter between an optical element and optical waveguide , and transmission of a lightwave signal be check can be manufacture suitably .
[0081]
Moreover, it is hard it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.
Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.
[0082]
By the manufacture approach of the above-mentioned device for optical communication, the substrate for IC chip mounting and a multilayer printed wiring board are manufactured independently first.
Therefore, suppose that the manufacture approach of the substrate for IC chip mounting and the manufacture approach of a multilayer printed wiring board are explained independently, and how to form a closure resin layer is explained after that first here. .
[0083]
First, the manufacture approach of the substrate for IC chip mounting is explained.

(1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit.
As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine resin (BT resin) substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example.
Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used.
the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.
[0084]
moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a breakthrough, the through hole is formed by performing nonelectrolytic plating processing etc.
Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.
[0085]
(2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit.
as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned.
In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.
[0086]
(3) next, a conductor — form the resin layer which forms the non-hardened resin layer which consists of thermosetting resin, a photopolymer, the resin with which the photosensitive radical was given to some thermosetting resin, these and thermoplastics, and included resin complex on the substrate in which the circuit was formed, or consists of thermoplastics.
The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening).
Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated in the shape of a film.
[0087]
In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc.
Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.
[0088]
As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example.
As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.
[0089]
As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example.
Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic—ization-react as resin with which the photosensitive radical was given to some above-mentioned thermosetting resin for example, is mentioned.
[0090]
As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF),

polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.
[0091]
Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin with which the photosensitive radical was given to some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, the epoxy resin that acrylic-ized a part of epoxy group, polyether sulfone, etc. are mentioned, for example.
[0092]
Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.
[0093]
Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer.
It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc.
While securing the outstanding adhesion with an insulating substrate by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at an after process is securable.
[0094]
Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation.
The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer.
In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.
[0095]
In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, a photopolymer may be used. In addition, when a photopolymer is used, exposure and a development can be used for the resin insulating layer between layers, and opening for the Bahia halls can be formed.
[0096]
As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)--ization-react using a methacrylic acid, an acrylic acid, etc.
[0097]
As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.
[0098]
As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0099]
It is desirable that it is at least one sort as which the matter of fusibility is chosen from an inorganic particle, a

resin particle, and metal particles to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer.

[0100]

As the above-mentioned inorganic particle, what consists of silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.

[0101]

As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. are mentioned. These may be used independently and may be used together two or more sorts.

In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle will dissolve in the solvent in which a resin matrix is dissolved if it is not made to harden.

Moreover, as the above-mentioned resin particle, a rubber particle, liquid phase resin, liquid phase rubber, etc. may be used.

[0102]

As the above-mentioned metal particles, gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.

Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.

[0103]

When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the resin insulating layer between layers which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of the resin insulating layer between layers — a crack — not generating — the resin insulating layer between layers, and a conductor — it is because exfoliation does not occur between circuits.

[0104]

It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. It is because it is hard to make the metallic conductor layer exposed from the Bahia hall corrode when roughening processing is carried out.

As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example.

Moreover, as the above-mentioned alkali, water solutions, such as a sodium hydroxide and a potassium hydroxide, are desirable.

[0105]

The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less.

Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.5 micrometers, and the matter of the fusibility whose mean particle diameter's is 1-2 micrometers etc.

[0106]

Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed.

Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the

practical Peel reinforcement is maintainable.
Mean particle diameter exceeds 0.8 micrometers, and that of the above-mentioned coarse grain is less than 2.0 micrometers, and, as for a particle, it is desirable for mean particle diameter to be 0.1-0.8 micrometers.
[0107]
(4) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as the resin insulating layer between layers. Moreover, at this process, a breakthrough may be formed if needed.
As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of the resin insulating layer between layers, you may form by the exposure development.
[0108]
Moreover, in forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as the resin insulating layer between layers. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this breakthrough by drilling, the lasing, etc., when forming a breakthrough at this process.
[0109]
As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.
[0110]
Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed in a resin film layer efficiently by exposure by using this method.
[0111]
Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds.
Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts.
Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.
[0112]
(5) next, the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls — a conductor — form a circuit.
a conductor — in forming a circuit, a thin film conductor layer is first formed in the front face of the resin insulating layer between layers.
The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.
[0113]
As construction material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example.
In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, profitability, etc. is desirable.
Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.3-2.0 micrometers is desirable and 0.6-1.2 micrometers is more desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.
[0114]
Moreover, a roughening side may be formed in the front face of the resin insulating layer between layers before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of the resin insulating layer between layers and a thin film conductor layer can be raised. When the resin insulating layer between layers is especially formed using the resin constituent for roughening side formation, it is desirable to form a roughening side using an acid, an oxidizer, etc.
[0115]
Moreover, when a breakthrough is formed at the process of the above (4), in case a thin film conductor layer is formed on the resin insulating layer between layers, it is good also as a through hole by forming a thin film

conductor layer also in the wall surface of a breakthrough.
[0116]
(6) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face.
After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0117]
(7) After that, electroplate by making a thin film conductor layer into a plating bar, and form a electroplating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electroplating, copper plating is desirable.
Moreover, the thickness of the above-mentioned electroplating layer has desirable 5-20 micrometers.
[0118]
Then, the thing for which the nonelectrolytic plating film and thin film conductor layer under the above-mentioned plating resist and this plating resist are removed — a conductor — a circuit (the Bahia hall is included) can be formed.
What is necessary is just to perform clearance of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform clearance of the above-mentioned plating resist for example, using an alkali water solution etc.
moreover, the above — a conductor — after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because lowering of an electrical property can be prevented.
[0119]
In addition, the conductor indicated here — the conductor in the manufacture approach of this invention although the formation approach of a circuit is an additive process — the formation approach of a circuit may not necessarily be limited to an additive process, for example, may be a subtractive process.
the following and a subtractive process — a conductor — how to form a circuit is explained briefly.
[0120]
That is, after forming first the resin insulating layer between layers which has opening for the Bahia halls, a thin film conductor layer is further formed in the front face of the resin insulating layer between layers containing the wall surface of opening for the Bahia halls like the process of the above (5).
[0121]
Next, thickness of a conductor layer is made thicker than forming a electroplating layer etc. the whole surface on the above-mentioned thin film conductor layer. In addition, what is necessary is just to perform formation of a electroplating layer etc. if needed.
Subsequently, etching resist is formed on the above-mentioned conductor layer.
After the above-mentioned etching resist sticks for example, a photosensitive dry film, it carries out adhesion arrangement of the photo mask on this photosensitive dry film, and forms it by performing an exposure development.
[0122]
Furthermore, the conductor which became independent on the resin insulating layer between layers by etching processing removing the above-mentioned etching-resist agenesis subordinate's conductor layer, and exfoliating etching resist after that — a circuit (the Bahia hall is included) is formed.
In addition, the above-mentioned etching processing can be performed using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, and exfoliation of etching resist can be performed using an alkali water solution etc.
The case where such an approach is used — the resin insulating-layer top between layers — a conductor — a circuit can be formed.
[0123]
In addition, a conductor — or [whether an additive process is chosen as the formation approach of a circuit, or / choosing a subtractive process] — a conductor — what is necessary is just to choose suitably in consideration of numbers, pitches, etc. of a connection terminal, such as the width of face and spacing of a circuit, IC chip to mount, and an optical element, other various electronic parts
[0124]
Moreover, when a through hole is formed in the above (4) and the process of (5), it may be filled up with a resin filler in this through hole.

Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0125]
(8) next, the thing for which roughening processing is performed on the front face of this lid plating layer, and the process of (3) - (7) is further repeated if needed when a lid plating layer is formed — the both sides — the resin insulating layer between layers, and a conductor — carry out laminating formation of the circuit. In addition, a through hole may be formed and it is not necessary to form at this process.
[0126]
Moreover, on both sides of the side and substrate with which an optical element counters a multilayer printed wiring board, it is mounted in an opposite hand, and in manufacturing the substrate for IC chip mounting with which the optical path for lightwave signal transmission was formed, in the process of the above (8), the breakthrough (henceforth the breakthrough for optical paths) which penetrates a substrate and the resin insulating layer between layers is formed, and it forms the resin layer for optical paths in this breakthrough for optical paths further if needed.
moreover — the case where the optical path for lightwave signal transmission by which the conductor layer was formed in that wall surface is formed — the process of the above (8) — setting — the conductor of an outermost layer of drum — the breakthrough for optical paths which penetrates a substrate and the resin insulating layer between layers before forming a circuit — forming — this conductor — what is necessary is just to form a conductor layer in the wall surface of the breakthrough for optical paths simultaneously, in case a circuit is formed in addition, formation of the above-mentioned conductor layer and the conductor of an outermost layer of drum — formation of a circuit is independently good in a line.
[0127]
What is necessary is for drilling, the lasing, etc. just to perform formation of the above-mentioned breakthrough for optical paths.
moreover, especially the formation location of the above-mentioned breakthrough for optical paths is limited — not having — a conductor — what is necessary is just to choose suitably in consideration of the design of a circuit, an optical element, the mounting position of IC chip, etc.
Furthermore, when forming the above-mentioned breakthrough for optical paths, as for this breakthrough for optical paths, it is desirable to form for every optical elements, such as a photo detector and a light emitting device. Moreover, you may form for every signal wave length.
[0128]
After forming the breakthrough for optical paths, DESUMIA processing may be performed if needed. The above-mentioned DESUMIA processing can be performed using processing for example, by the permanganic acid solution, plasma treatment, corona treatment, etc. In addition, by performing the above-mentioned DESUMIA processing, the resin remainder in the breakthrough for optical paths, weld flash, etc. can be removed, and the transmission loss resulting from the scattered reflection in the wall surface of the optical path for lightwave signal transmission can be reduced.
[0129]
Moreover, a roughening side may be formed in the wall surface of the above-mentioned breakthrough for optical paths. By forming a roughening side, it is because improvement in adhesion with a conductor layer or the resin layer for optical paths can be aimed at.
Formation of the above-mentioned roughening side can be performed by dissolving the part exposed with oxidizers, such as acid; chromic acids, such as a sulfuric acid, a hydrochloric acid, and a nitric acid, chromate acid mixture, and a permanganate, etc. when breakthroughs for optical paths, such as a substrate and a resin insulating layer between layers, were formed. Moreover, plasma treatment, corona treatment, etc. can also perform.
Furthermore, a roughening side may be formed in the front face of this conductor layer after forming the above-mentioned conductor layer.
[0130]
Formation of the above-mentioned resin layer for optical paths is filled up with a non-hardened resin constituent in the above-mentioned breakthrough for optical paths, and is performed by performing hardening processing after that.
It is not limited especially as an approach filled up with a non-hardened resin constituent, for example, approaches, such as printing and potting, can be used.
In addition, when filled up with a non-hardened resin constituent by printing, it may be filled up with this resin constituent at once, and may be filled up with it in 2 steps or more. Moreover, printing may be performed from the both sides of a multilayer-interconnection plate.

[0131]
Moreover, in case it is filled up with a non-hardened resin constituent, it may be filled up with the resin constituent which is not hardened [of somewhat many amounts], and the excessive resin constituent with which it overflowed from the breakthrough for optical paths may be removed from the inner product of the above-mentioned breakthrough for optical paths after restoration termination.
the above -- polish etc. can perform clearance of an excessive resin constituent. Moreover, what is necessary is for the condition of a resin constituent to be in a semi-hardening condition, to be in the condition hardened thoroughly, and just to choose it suitably in consideration of the ingredient of a resin constituent etc., when removing an excessive resin constituent.
By performing such processing, the optical path for lightwave signal transmission which penetrates the above-mentioned multilayer-interconnection plate can be formed.
[0132]
(9) next, a conductor -- form a solder resist layer in the outermost layer of drum of the substrate in which the circuit and the resin insulating layer between layers were formed.
The above-mentioned solder resist layer can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.
[0133]
moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C.
Moreover, a commercial solder resist constituent may be used.
[0134]
(10) Next, form opening for solder bump formation (opening for connecting with opening for mounting IC chip, or a multilayer printed wiring board), and opening for optical element mounting in the above-mentioned solder resist layer.
Formation of the above-mentioned opening for solder bump formation or the above-mentioned opening for optical element mounting can be performed using the approach of forming for example, opening for the Bahia halls, and the same approach, i.e., an exposure development, the lasing, etc.
Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical element mounting may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
[0135]
In addition, when manufacturing the substrate for IC chip mounting which has an optical path for lightwave signal transmission, it is desirable to form in a solder resist layer opening for optical paths which was open for free passage to the above-mentioned breakthrough for optical paths at this process. Moreover, when opening for optical paths is formed, it may be filled up with a resin constituent in this opening for optical paths, and the thing same as the above-mentioned resin constituent as the resin constituent with which it is filled up in the above-mentioned breakthrough for optical paths etc. is mentioned.
[0136]
(11) next, the conductor exposed by forming the above-mentioned opening for solder bump formation, and the above-mentioned opening for optical element mounting -- if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold.
Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.
moreover, the conductor exposed by forming opening for optical element mounting at this process -- it is desirable to form an enveloping layer (conductor layer for aiming at electric connection with an optical element) also in a circuit part.
[0137]
(12) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned

solder pad.
By forming such a solder bump, it becomes possible to mount IC chip or to connect a multilayer printed wiring board through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can connect these and the substrate for IC chip mounting electrically through the bump of IC chip to mount or the multilayer printed wiring board to connect.
[0138]
(13) An optical element (a photo detector and light emitting device) is further mounted in a solder resist layer. As a concrete approach of connecting by wirebonding or flip chip bonding, a well-known approach can be used conventionally that what is necessary is just to perform mounting of an optical element according to the connection modes (for example, wirebonding, flip chip bonding, etc.) of this optical element.
[0139]
Moreover, the above-mentioned optical element may be mounted so that the part or all may be laid under the solder resist layer, may not lay the all underground but may mount them in a front face.
Therefore, what is necessary is just to determine suitably the magnitude of opening for optical element mounting formed at the process of the above (10) according to the mounting mode of an optical element.
Furthermore, at this process, after mounting an optical element, the resin seal of that perimeter may be carried out.
[0140]
Next, the manufacture approach of a multilayer printed wiring board is explained.
(1) first — the process of (1) - (2) of the manufacture approach of the above-mentioned substrate for IC chip mounting — the same — carrying out — both sides of a substrate — a conductor — the conductor which forms a circuit and whose substrate was both pinched — form the through hole which connects between circuits. moreover — this process — a conductor — a roughening side is formed in the front face of a circuit, or the wall surface of a through hole if needed.
[0141]
(2) next, the need — responding — a conductor — a substrate [in which the circuit was formed] top — the resin insulating layer between layers, and a conductor — carry out laminating formation of the circuit.
concrete — the same approach as the process of (3) - (8) of the manufacture approach of the above-mentioned substrate for IC chip mounting — using — the resin insulating layer between layers, and a conductor — what is necessary is just to carry out laminating formation of the circuit
Also in this process, the through hole which penetrates a substrate and the resin insulating layer between layers may be formed like the case where the substrate for IC chip mounting is manufactured, or a lid plating layer may be formed.
in addition, this process of (2), i.e., the resin insulating layer between layers, and a conductor — the process which carries out the laminating of the circuit may be performed once, and is good in a multiple-times line.
moreover, this process — the resin insulating-layer top between layers — a conductor — a subtractive process may be used like the case where the substrate for IC chip mounting is manufactured, as an approach of forming a circuit.
[0142]
moreover, in case optical waveguide is formed at the process mentioned later, in forming this optical waveguide in the resin insulating-layer up between layers of an opposite hand etc. on both sides of the side and substrate which counter the substrate for IC chip mounting In this process, by the approach explained by the manufacture approach of the substrate for IC chip mounting mentioned above, and the same approach, if needed, the resin layer for optical paths is formed in that interior, or the breakthrough for optical paths by which the conductor layer was formed in that wall surface is formed.
In addition, formation of the breakthrough for optical paths (optical path for lightwave signal transmission) which penetrates this substrate etc. may be performed after forming optical waveguide at the process of following (3).
[0143]
(3) next, the conductor on the substrate for IC chip mounting, the substrate of the side which counters, or the resin insulating layer between layers — form optical waveguide in the circuit agenesis section.
Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient.
moreover, the optical waveguide which consists of the above-mentioned inorganic material — for example, $LiNbO_3$ and $LiTaO_3$ etc. — it can form by making an inorganic material form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.
[0144]

As an approach of forming the optical waveguide which consists of a polymer ingredient, for example Moreover, **1 The approach of sticking the film for optical waveguide formation beforehand fabricated in the shape of a film to the mold releasing film up etc. on the resin insulating layer between layers, and **2 The approach of forming direct optical waveguide on the above-mentioned resin insulating layer between layers etc. is mentioned by carrying out laminating formation of a lower clad, a core, and the up clad one by one on the resin insulating layer between layers.
In addition, as the formation approach of optical waveguide, also when forming optical waveguide on a mold releasing film, and also when forming optical waveguide on the resin insulating layer between layers, it can carry out using the same approach.
Specifically, the approach using reactive ion etching, the exposure developing-negatives method, the metal mold forming method, the resist forming method, the approach that combined these can be used.
[0145]
the approach using the above-mentioned reactive ion etching — (i) — first, a lower clad is formed on a mold releasing film, the resin insulating layer between layers (only henceforth a mold releasing film etc.), etc., the resin constituent for cores is applied on (ii), next this lower clad, and it considers as the resin layer for core formation by performing hardening processing further if needed. (iii) Next, a mask (etching resist) is formed on the resin layer for core formation by forming the resin layer for mask formation on the above-mentioned resin layer for core formation, and subsequently performing an exposure development to the resin layer for this mask formation.

[0146]
(iv) Next, by giving reactive ion etching to the resin layer for core formation, the resin layer for core formation of a mask agenesis part is removed, and a core is formed on a lower clad. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
The approach using this reactive ion etching can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0147]
moreover — the exposure developing-negatives method — (i) — first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and the layer of the resin constituent for core formation is further formed by performing semi-hardening if needed.
[0148]
(iii) Next, a core is formed on a lower clad by laying the mask with which the pattern corresponding to a core formation part was drawn on the layer of the above-mentioned resin constituent for core formation, and performing an exposure development after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
Since there are few routing counters, in case this exposure developing-negatives method mass-produces optical waveguide, it can be used suitably, and since there are few heating processes, stress cannot generate it easily in optical waveguide.
[0149]
moreover — the above-mentioned metal mold forming method — (i) — first, a lower clad is formed on a mold releasing film etc., and the slot for core formation is formed in (ii), next a lower clad by metal mold formation. (iii) Further, above-mentioned Mizouchi is filled up with the resin constituent for cores by printing, and a core is formed by performing hardening processing after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
In case this metal mold forming method mass-produces optical waveguide, it can be used suitably, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0150]
moreover — the above-mentioned resist forming method — (i) — first — a mold releasing film etc. top — a lower clad — forming — (ii) — further, after applying the resin constituent for resists on this lower clad, resist formation for core formation is carried out by performing an exposure development at the core agenesis part on the above-mentioned lower clad.
[0151]
(iii) Next, after the resin constituent for cores applying to the resist agenesis part on a lower clad and hardening the resin constituent for cores to the (iv) pan, a core is formed on a lower clad by exfoliating the above-mentioned resist for core formation. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
In case this metal mold forming method mass-produces optical waveguide, it can be suitably used for this resist

forming method, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0152]
Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide.
Although you may form before attaching the above-mentioned optical-path conversion mirror on the resin insulating layer between layers, and you may form after attaching on the resin insulating layer between layers, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on the resin insulating layer between layers. other members which can work easily and constitute a multilayer printed wiring board at the time of an activity, for example, a substrate, and a conductor — it is because a blemish is attached to a circuit, the resin insulating layer between layers, etc. or there is no possibility of damaging these.
[0153]
It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose head is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.
In addition, although how to form optical waveguide on a substrate or the resin insulating layer between layers of an outermost layer of drum is explained, when manufacturing the above-mentioned multilayer printed wiring board, the above-mentioned optical waveguide may be formed here between a substrate and the resin insulating layer between layers, and among the resin insulating layers between layers.
[0154]
In forming optical waveguide between a substrate and the resin insulating layer between layers the process of the above (1) — the both sides — a conductor, after producing the substrate with which the circuit was formed the same approach as the process of the above (3) — the conductor on a substrate — optical waveguide can be formed in the above-mentioned location by forming optical waveguide in a circuit agenesis part, and forming the resin insulating layer between layers by the same approach as the process of the above (2) after that.
[0155]
moreover, in forming optical waveguide among the resin insulating layers between layers the above (1) and the process of (2) — the same — carrying out — a conductor, after carrying out laminating formation of the resin insulating layer between at least one-layer layers on the substrate with which the circuit was formed Optical waveguide can be formed among the resin insulating layers between layers by forming optical waveguide on the resin insulating layer between layers like the process of the above (3), and repeating the process of the above (2), and the same process after that further.
[0156]
(4) Next, form a solder resist layer in the outermost layer of drum of the substrate in which optical waveguide was formed.
The above-mentioned solder resist layer can be formed using the resin constituent used when forming the solder resist layer of for example, the above-mentioned substrate for IC chip mounting, and the same resin constituent.
In addition, depending on the case, optical waveguide is formed in the whole outermost layer of drum of a substrate at the process of the above (3), and you may make it optical waveguide play a role of a solder resist layer.
[0157]
(5) Next, form opening for solder bump formation (opening for mounting the substrate for IC chip mounting, and various surface mount mold electronic parts), and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters.
Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an exposure development, the lasing, etc.
In addition, formation of the above-mentioned opening for solder bump formation and formation of opening for optical paths may be performed simultaneously, and are independently good in a line.
[0158]
In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development.
It is because there is no possibility of attaching a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development.

Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
In addition, when the breakthrough for optical paths is formed and optical waveguide is formed in the opposite hand whose substrate was pinched the side which counters the substrate for IC chip mounting, in case opening for optical paths is formed at this process, it forms so that this opening for optical paths may be opened for free passage with the above-mentioned breakthrough for optical paths.
[0159]
Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand if needed.
By passing through an after process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand.
[0160]
(6) next, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out using the same approach as the process of (11) of the manufacture approach of the substrate for IC chip mounting.
[0161]
(7) Next, in opening for optical paths formed at the process of the above (5), it is filled up with a non-hardened resin constituent and form the resin layer for optical paths by performing hardening processing after that if needed.
In addition, as for the resin constituent which is not hardened [which is filled up with this process], it is desirable that it is the same as that of the resin constituent filled up with the production process of the substrate for IC chip mounting into the breakthrough for optical paths and opening for optical paths.
Moreover, as mentioned above, in order to form optical waveguide in the opposite hand whose substrate was pinched the side which counters the substrate for IC chip mounting Also when the breakthrough for optical paths and opening for optical paths are formed, this breakthrough for optical paths and this opening for optical paths may be filled up with a non-hardened resin constituent. Here When filled up with the resin constituent which is not hardened [above-mentioned] May fill up simultaneously the above-mentioned breakthrough for optical paths, and the above-mentioned opening for optical paths, may perform the postcure processing, and After forming the breakthrough for optical paths in a multilayer-interconnection plate, restoration and hardening processing of a resin constituent in which it does not harden are performed, after that, the solder resist layer which has opening for optical paths may be formed, and restoration and hardening processing of a resin constituent in which it does not harden may be performed further.
[0162]
(8) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad.
By forming such a solder bump, it becomes possible to mount the substrate for IC chip mounting, and various surface mount mold electronic parts through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can mount these through the bump of the substrate for IC chip mounting, or various surface mount mold electronic parts who mounts.
Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by not forming an external connection terminal, arranging a pin or forming a solder ball if needed, especially in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand.
By passing through such a process, the multilayer printed wiring board which constitutes the device for optical communication of this invention can be manufactured.
[0163]
By the manufacture approach of the device for optical communication of this invention next, between the optical element of the substrate for IC chip mounting, and the optical waveguide of a multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it.
Here, both are fixed, while forming a solder connection by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board and connecting both electrically, after carrying out opposite arrangement of the substrate for IC chip mounting, and the multilayer printed wiring board. That is, both are connected by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board to a position with the predetermined sense, respectively.

ddition, as mentioned above, the solder bump for fixing both substrate for IC chip mounting and multilayer :ed wiring board may be formed only in one of both.
4]
eover, at this process, even if some location gap exists among both when opposite arrangement of both is ied out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using solder bump, both can be stationed to a position according to the self-alignment effectiveness which solder at the time of a reflow.
;5]
t, the resin constituent for closure is slushed between the above-mentioned substrate for IC chip mounting, the above-mentioned multilayer printed wiring board, and a closure resin layer is formed in it by performing lening processing after that.
one resin mentioned above as the above-mentioned resin constituent for closure, such as polyimide resin; xy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA; that with :h resinous principles, such as a polymer manufactured from benz-cyclo-butene, and the particle contained if ded were resembled, in addition various additives, such as a curing agent, a defoaming agent, an acid ydride, and a solvent, were blended suitably is mentioned.
eover, as for the above-mentioned resin constituent for closure, it is desirable for the permeability of the munication link wavelength light after hardening to be 70% or more, and it is more desirable that it is 90% or e.
;6]
it is necessary is here, just to choose suitably in consideration of the design of the presentation of the resin stituent for closure, the substrate for IC chip mounting, and a multilayer printed wiring board etc. as the osity of the resin constituent for closure slushed between the substrate for IC chip mounting, and a tilayer printed wiring board, and conditions for the hardening processing after slushing this resin constituent closure.
;7]
:t, IC chip is mounted in the substrate for IC chip mounting, and it considers as the device for optical munication by performing the resin seal of IC chip after that if needed.
unting of the above-mentioned IC chip can be conventionally performed by the well-known approach.
eover, it is good also as a device for optical communication by connecting the substrate for IC chip mounting multilayer printed wiring board which performed mounting of IC chip before connecting the substrate for IC mounting, and a multilayer printed wiring board, and mounted IC chip.
ddition, as a resin constituent used in case the resin seal of the IC chip is carried out, the well-known resin stituent for IC chip closure can be used conventionally, and the particle may be blended with this resin stituent.
;8]
ample]
eafter, this invention is further explained to a detail.
ample 1)
Production of the substrate for IC chip mounting
. Production of the resin film for the resin insulating layers between layers
: bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy npany) 30 weight section, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N- : by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin enol nature hydroxyl equivalent 120, FENO [by Dainippon Ink & Chemicals, Inc.] light KA- 7052) 30 weight tion The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers nation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5- ew (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and silicone system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was pared.
er applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a Γ film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating ers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
69]
2. Preparation of the resin constituent for breakthrough restoration

equipment by the approach of further the following (refer to drawing 4 (e)).
That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0177]
(7) Next, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the breakthrough with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 5 (a)).
[0178]
(8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers.
[0179]
(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).
Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0180]
(10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the non-electrolytic copper plating film 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 5 (b)).
[0181]
[Nonelectrolytic plating water solution]
NiSO4 0.003 mol/l
Tartaric acid 0.200 mol/l
Copper sulfate 0.030 mol/l
HCHO 0.050 mol/l
NaOH 0.100 mol/l
alpha and alpha'-bipyridyl 100 mg/l
Polyethylene-glycol (PEG) 0.10 g/l
[Nonelectrolytic plating conditions]
It is 40 minutes by whenever [30-degree C solution temperature].
[0182]
(11) Next, the plating resist 23 with a thickness of 20 micrometers was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 5 (c)).
[0183]
(12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 5 (d)).
[0184]
[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l
Copper sulfate 0.26 mol/l
Additive 19.5 ml/l
(Made in ATOTEKKU Japan, KAPARASHIDO GL)

[Electrolysis plating conditions]
Current density 1 A/dm2
Time amount 65 Part
Temperature 22**2 **
[0185]
(13) — a conductor with a thickness of 18 micrometers which carries out etching processing of the nonelectrolytic plating film under plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% — the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 6 (a)).
[0186]
(14) next, the thing for which the process of above-mentioned (5) - (12) is repeated — the upper resin insulating layer between layers, and a conductor — laminating formation of the circuit was carried out (refer to drawing 6 (b) and (c))
furthermore, the etching reagent used at the process of the above (5) and the same etching reagent (MEKKU dirty bond) — using — a conductor — the roughening side (not shown) was formed in circuit 25 (the Bahia hall 27 is included) front face.
[0187]
(15) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 4.5 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent.
In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).
[0188]
(16) next, the resin insulating layer 22 between layers and a conductor — the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 (the Bahia hall 27 is included) was formed, the condition for 30 minutes at 70 degrees C, and layer 34' of a solder REJISU constituent was formed in them (refer to drawing 7 (a)).
[0189]
(17) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical element (photo detector and light emitting device) mounting was drawn was stuck in the layer of one solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, and the development was carried out with the DMTG solution.
And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 35 for solder bump formation, and the opening 31 for optical element mounting, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed. In addition, the diameter is 150 micrometers and the spacing of the opening 35 for solder bump formation is 250 micrometers.
Moreover, the opening 35 for mounting IC chip was formed in the layer of the solder resist constituent of another side by sticking the photo mask with which the pattern of opening for mounting IC chip was drawn, and performing an exposure development on the above-mentioned exposure development conditions and the same conditions (refer to drawing 7 (b)).
In addition, the diameter of opening for solder bump formation is usually about 50-200 micrometers, and the spacing is usually about 100-250 micrometers.
[0190]
(18) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed

nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 35 for solder bump formation, and the opening 31 for optical element mounting. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10 to 1 mol/l.) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36 and the pad 42 for optical element connection.

[0191]

(19) Next, the resin for die bondings was used into the opening 31 for optical element mounting in which the solder resist layer 34 was formed, and the photo detector 38 and the light emitting device 39 were attached, performing alignment of a light sensing portion and a light-emitting part.

In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs.

Next, the photo detector 38 and the light emitting device 39, and the pad 42 for optical element connection exposed to the base of the opening 31 for optical element mounting were connected by wirebonding. The wire made from Au was used as a wire 45 here.

[0192]

Next, the resin seal of the perimeter of an optical element 38 and a light emitting device 39 was carried out by the following approach.

That is, the perimeter of an optical element was closed with resin 47 by filling up with a heat-curing mold epoxy resin and 1-10-micrometer particle size distribution the resin constituent which is not hardened containing a particle with a mean particle diameter of 5 micrometers, an acid anhydride, a defoaming agent, and a curing agent in the opening 31 for optical element mounting which mounted optical elements 38 and 39, and performing hardening processing after that.

[0193]

(20) Next, soldering paste was printed to the opening 35 for solder bump formation formed in the solder resist layer 34, and the solder bump 37 was formed by carrying out a reflow at 200 degrees C, and further, the solder bump was formed also like opening for mounting IC chip, and it considered as the substrate for IC chip mounting.

[0194]

B. Production of a multilayer printed wiring board

B-1. Production of the resin film for the resin insulating layers between layers

The resin film for the resin insulating layers between layers was produced using the approach used by A-1, and the same approach.

B-2. Preparation of the resin constituent for breakthrough restoration

The resin constituent for breakthrough restoration was produced using the approach used by A-2, and the same approach.

[0195]

B-3. Manufacture of a multilayer printed wiring board

(1) Copper clad laminate which 18-micrometer copper foil 8 laminates to both sides of the insulating substrate 1 which consists of a glass epoxy resin with a thickness of 0.6mm or BT resin was used as the start ingredient (refer to drawing 9 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern -- both sides of a substrate 1 -- a conductor -- the circuit 4 and the through hole 9 were formed (refer to drawing 9 R> 9 (b)).

[0196]

(2) a through hole 9 and a conductor -- the conductor which washes in cold water the substrate in which the circuit 4 was formed, and includes blasting and a through hole 9 for an etching reagent (the product made from MEKKU, MEKKU dirty bond) by the spray after drying -- the roughening side (not shown) was formed in the front face of a circuit 4.

[0197]

(3) the following approach after preparing the resin filler indicated to the above B-2 -- after preparation -- less than 24 hours -- the conductor in a through hole 9 and on a substrate 1 -- the circuit agenesis section and a conductor -- the layer of resin filler 10' was formed in the rim section of a circuit 4.

That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor -- the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using

the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 10' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 9 (c)).

[0198]

(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 10' might remain neither in the front face of a circuit 4, nor the land front face of a through hole 9, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.

Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 10 was formed.

[0199]

thus, a through hole 9 and a conductor — the surface section of the resin filler 10 formed in the circuit agenesis section, and a conductor — the front face of a circuit 4 — flattening — carrying out — the resin filler 10 and a conductor — the insulating substrate which the side face of a circuit 4 stuck firmly through the roughening side, and the internal surface and the resin filler 10 of a through hole 9 stuck firmly through the roughening side was obtained (refer to drawing 9 (d)). this process — the front face of the resin filler layer 10, and a conductor — the front face of a circuit 4 turns into the same flat surface.

[0200]

(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor -- etching the front face of a circuit 4, and the land front face of a through hole 9 — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 4. In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.

[0201]

(6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by the above B-1 was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 2 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 10 (a)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.

[0202]

(7) Next, the opening 6 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 2 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the breakthrough with a thickness of 1.2mm was formed on the resin insulating layer 2 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 10 (b)).

[0203]

(8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 6 for the Bahia halls by immersing the substrate in which the opening 6 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the resin insulating layer 2 between layers.

[0204]

(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).

Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out roughening side processing (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 6 for the Bahia halls to be included) of the resin insulating layer 2 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.

[0205]

(10) Next, the substrate was immersed into the non-electrolytic copper plating water solution, and the non-electrolytic copper plating film 12 with a thickness of 0.6-3.0 micrometers was formed in the front face (the internal surface of the opening 6 for the Bahia halls is included) of the resin insulating layer 2 between layers

(refer to drawing 10 (c)).
In addition, the used nonelectrolytic plating water solution and nonelectrolytic plating conditions are the same as that of (10) of the production process of the substrate for IC chip mounting.
[0206]
(11) The substrate in which the nonelectrolytic plating film 12 was formed was rinsed, electrolysis plating was performed after that, and the electrolytic copper plating film 13 with a thickness of 20 micrometers was formed on [whole] the nonelectrolytic plating film 12 (refer to drawing 11 (a)).
In addition, the used electrolysis plating water solution and electrolysis plating conditions are the same as that of (12) of the production process of the substrate for IC chip mounting.
[0207]
(12) Next, etching resist 3 was formed by sticking a commercial photosensitive dry film on the substrate with which the electrolytic copper plating film 13 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 11 (b)).
[0208]
(13) next, the conductor which consists of non-electrolytic copper plating film 12 and electrolytic copper plating film 13 by carrying out etching processing of an etching-resist agenesis subordinate's electrolytic copper plating film and nonelectrolytic plating film with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carrying out dissolution clearance and carrying out exfoliation clearance of the etching resist with a NaOH solution 5% after that — the circuit 7 (the Bahia hall 5 is included) was formed (refer to drawing 11 (c)).
furthermore, an etching reagent (MEKKU dirty bond) — using — a conductor — the roughening side (not shown) was formed in circuit 5 (the Bahia hall 7 is included) front face.
[0209]
(14) Next, the optical waveguide 18 (18a, 18b) which uses the following approaches for the position of resin insulating-layer 2 between layers front face, and has the optical-path conversion mirror 19 (19a, 19b) was formed (refer to drawing 12 (a)).
That is, beforehand, the optical waveguide (25 micrometers in width of face of 25 micrometers, thickness) of the shape of a film which consists of PMMA by which the head formed 45-degree optical-path conversion mirror 19 in the end using the diamond saw which is 90 degrees of V types was stuck so that the side face of the other end by the side of optical-path conversion mirror agenesis and the side face of the resin insulating layer between layers might gather.
In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the resin insulating layer between layers of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour.
In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0210]
(15) Next, the solder resist constituent was prepared like (15) of the production process of the substrate for IC chip mounting, further, the above-mentioned solder resist constituent was applied by the thickness of 35 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a substrate the condition for 30 minutes at 70 degrees C, and layer 14' of a solder resist constituent was formed in them (refer to drawing 12 (b)).
[0211]
(16) Subsequently, one side of a substrate was made to stick the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical paths was drawn to a solder resist layer, it exposed on it by the ultraviolet rays of 1000 mJ/cm2, the development was carried out to it with the DMTG solution, and opening with a diameter of 150 micrometers was formed in it at intervals of 250 micrometers.
And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has the opening 15 for solder bump formation, and the opening 11 (11a, 11b) for optical paths, and the solder resist layer 14 the thickness of whose is 20 micrometers was formed (refer to drawing 13 (a)).
[0212]
(17) Next, like the process of (18) of the production process of the substrate for IC chip mounting, the nickel-plating layer and the gilding layer were formed and it considered as the solder pad 16.
[0213]
(18) Next, soldering paste was printed to the opening 15 for solder bump formation formed in the solder resist

layer 14, and by carrying out a reflow at 200 degrees C, the solder bump 17 was formed in the opening 15 for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 13 (b)).
[0214]
C. Manufacture of the device for IC mounting optical communication
First, IC chip was mounted in the substrate for IC chip mounting manufactured through the process of Above A, the resin seal was performed after that, and IC chip mounting substrate was obtained.
Next, by making a position carry out opposite arrangement and carrying out a reflow of this IC chip mounting substrate and the multilayer printed wiring board manufactured through the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected and the solder connection was formed.
[0215]
Next, it was filled up with the non-hardened resin constituent for closure between the multilayer printed wiring boards and the substrates for IC chip mounting which were connected through the solder connection, and by performing hardening processing after that, the closure resin layer was formed and it considered as the device for optical communication (refer to drawing 1).
In addition, as a resin constituent for closure, the heat-curing mold epoxy resin and the resin constituent which contains a particle with a mean particle diameter of 5 micrometers, an acid anhydride, a defoaming agent, and a curing agent by 1-10-micrometer particle size distribution were used. Moreover, the viscosity of the above-mentioned resin constituent for closure is 5 Pa-s at 5min-1 (rpm) / 25 degrees C.
Moreover, the permeability of the formed closure resin layer was 85%.
In addition, the viscosity of the above-mentioned resin constituent for closure is usually 1 - 10 Pa-s extent at 5min-1 (rpm) / 25 degrees C.
[0216]
(Example 2)
In the process of (14) of the production process of the multilayer printed wiring board of an example 1, when forming optical waveguide, the following approach was used, it consisted of the lower clad, a core, and an up clad, and the device for optical communication was manufactured like the example 1 except having formed the optical waveguide in which the optical-path conversion mirror was formed on the resin insulating layer between layers of an outermost layer of drum.
By carrying out spreading membrane formation of the PMMA for lower clad formation, and carrying out heat hardening of this to the position on the resin insulating layer between layers of an outermost layer of drum first, formation of optical waveguide formed the lower clad and formed the core layer on the above-mentioned lower clad after that by carrying out spreading membrane formation of the PPMA for core formation, and carrying out heat hardening of this.
Then, the resist was applied on the surface of the core layer, the resist pattern was formed with photolithography and the core was formed on the lower clad by carrying out pattern NINGU at the configuration of a core by reactive ion etching.
Next, PMMA for up clad formation was applied on the above-mentioned core, and by carrying out heat hardening of this, the up clad was formed on the above-mentioned core, and it considered as optical waveguide. Then, 45-degree optical-path conversion mirror was formed in the end of this optical waveguide by machining.
In addition, the above-mentioned PMMA for lower clad formation and the above-mentioned PMMA for up clad formation consist of the same presentation.
[0217]
(Example 3)
In the process of (16) of the process of (17) of the production process of the substrate for IC chip mounting of an example 1, and the production process of a multilayer printed wiring board, when forming opening for solder bump formation, the diameter manufactured the device for optical communication like the example 1 by 70 micrometers except spacing having formed opening for solder bump formation which is 127 micrometers.
[0218]
Thus, while attaching an optical fiber in an exposed surface from the multilayer printed wiring board of the optical waveguide which counters a photo detector about the device for IC mounting optical communication of the acquired examples 1-3 It replaces with a photo detector and an optical fiber is minded for a detector installation and after that. A lightwave signal Delivery, When the detector detected the lightwave signal, the desired lightwave signal could be detected and the device for IC mounting optical communication manufactured by this example became clear [having the engine performance which can be enough satisfied as a device for optical communication].
[0219]
Moreover, when the waveguide loss between the light emitting device mounted in the substrate for IC chip

mounting, and this light emitting device and the optical waveguide which counters and which was formed in the multilayer printed wiring board was measured by the following approach, it is 0.3 or less dB/cm and it became clear that a lightwave signal can fully be transmitted.
In addition, measurement of waveguide loss was performed by detecting the lightwave signal which transmitted the lightwave signal whose measurement wavelength is 850nm from the optical fiber which attached the power meter in the edge by the side of the photo detector of the optical path for lightwave signal transmission installation and after that through the optical fiber at optical waveguide, and was transmitted through the optical waveguide for light-receiving, and the optical path for lightwave signal transmission with a power meter while attaching the optical fiber in the edge of the optical waveguide for light-receiving.
[0220]
Furthermore, in the device for optical communication obtained in the examples 1-3, most location gaps from the design of an optical element (a photo detector and light emitting device) and optical waveguide were not seen.
[0221]
[Effect of the Invention]
Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position as described above, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
[0222]
Moreover, in the device for optical communication of this invention, as described above, the closure resin layer is formed, and since dust, a foreign matter, etc. which are floating the inside of air between an optical element and optical waveguide do not enter and transmission of a lightwave signal is not checked with this dust, foreign matter, etc., it will excel in the dependability as a device for optical communication.
Furthermore, since the duty with which this closure resin layer eases the stress generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board by forming the closure resin layer can be achieved and it is harder coming to generate location gap of an optical element and optical waveguide, the device for optical communication of this invention will be excellent in dependability.
[0223]
By the manufacture approach of the device for optical communication of this invention , since a closure resin layer be form among both after arrange and fix the substrate for IC chip mounting , and a multilayer printed wiring board to a position , the device for optical communication with which neither float - inside of air dust nor a foreign matter enter between an optical element and optical waveguide , and transmission of a lightwave signal be check can be manufacture suitably .
[0224]
Moreover, it is hard it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.
Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.
[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC

chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 13] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 14] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 15] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Description of Notations]
100 Multilayer Printed Wiring Board
101 Substrate
102 Resin Insulating Layer between Layers
104 Conductor — Circuit
107 Bahia Hall
109 Through Hole
111 Opening for Optical Paths
114 Solder Resist Layer
118 Optical Waveguide
119 Optical-Path Conversion Mirror
120 Substrate for IC Chip Mounting
121 Substrate
122 Resin Insulating Layer between Layers
124 Conductor — Circuit
127 Bahia Hall
129 Through Hole
131 Opening for Optical Element Mounting
134 Solder Resist Layer
137 Solder Connection
138 Photo Detector
139 Light Emitting Device
140 IC Chip
142 Conductive Layer
150 Device for Optical Communication
160 Closure Resin Layer

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 13] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 14] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 15] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Description of Notations]
100 Multilayer Printed Wiring Board
101 Substrate
102 Resin Insulating Layer between Layers
104 Conductor — Circuit
107 Bahia Hall
109 Through Hole
111 Opening for Optical Paths
114 Solder Resist Layer
118 Optical Waveguide
119 Optical-Path Conversion Mirror
120 Substrate for IC Chip Mounting
121 Substrate
122 Resin Insulating Layer between Layers

124 Conductor -- Circuit
127 Bahia Hall
129 Through Hole
131 Opening for Optical Element Mounting
134 Solder Resist Layer
137 Solder Connection
138 Photo Detector
139 Light Emitting Device
140 IC Chip
142 Conductive Layer
150 Device for Optical Communication
160 Closure Resin Layer

[Translation done.]